AD740402

20 March 1972
25p.

THE SUPPLY OF VOLUNTEERS TO THE ARMED FORCES REVISITED

by

James T. Bennett
Sheldon E. Haber
Peter J. Kinn

Serial T-260

Serial T-260
20 March 1972

The George Washington University
Institute for Management Science and Engineering
Program in Logistics

Contract N00014-67-A-0214
Task 0001, Project NR 347 020
Office of Naval Research

NONE

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) THE GEORGE WASHINGTON UNIVERSITY PROGRAM IN LOGISTICS	2a. REPORT SECURITY CLASSIFICATION NONE 2b. GROUP

3. REPORT TITLE

THE SUPPLY OF VOLUNTEERS TO THE ARMED FORCES REVISITED

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

SCIENTIFIC

5. AUTHOR(S) (First name, middle initial, last name)

BENNETT, JAMES T., HABER, SHELDON E. and KINN, PETER J.

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
20 March 1972	25	16

8a. CONTRACT OR GRANT NO. N00014-67-A-0214	9a. ORIGINATOR'S REPORT NUMBER(S) T-260
b. PROJECT NO. NR 347 020	
c.	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
d.	

10. DISTRIBUTION STATEMENT

This document has been approved for public release and sale; its distribution is unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	Office of Naval Research

13. ABSTRACT The objective of this paper is to re-examine wage and unemployment elasticities of the supply of volunteers to the United States Armed Forces in the absence of the draft. It is shown that earlier studies are misspecified due to the omission of a measure of the resources employed in manpower procurement. When a resource variable is included in the supply equation, wage and unemployment elasticities based upon 1970 data are obtained which are substantially lower than those reported earlier. This implies that volunteers may not be as responsive to wage increases as previously assumed, which could make the wage increases to raise an all-volunteer military establishemnt much greater than anticipated. Further, consideration is given to the economic trade-off between military wage increases and increased utilization of recruiting resources, a trade-off which has been overlooked by earlier investigators.

DD FORM 1 NOV 65 1473

NONE

Security Classification

NONE
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Volunteers						
Draft						
Recruiters						
Elasticity						
Manpower						

NONE
Security Classification

THE GEORGE WASHINGTON UNIVERSITY
School of Engineering and Applied Science
Institute for Management Science and Engineering

Program in Logistics

Abstract
of
Serial T-260
20 March 1972

THE SUPPLY OF VOLUNTEERS TO THE ARMED FORCES REVISITED

by

James T. Bennett
Sheldon E. Haber
Peter J. Kinn

The objective of this paper is to re-examine wage and unemployment elasticities of the supply of volunteers to the United States Armed Forces in the absence of the draft. It is shown that earlier studies are misspecified due to the omission of a measure of the resources employed in manpower procurement. When a resource variable is included in the supply equation, wage and unemployment elasticities based upon 1970 data are obtained which are substantially lower than those reported earlier. This implies that volunteers may not be as responsive to wage increases as previously assumed, which could make the wage increases to raise an all-volunteer military establishment much greater than anticipated. Further, consideration is given to the economic trade-off between military wage increases and increased utilization of recruiting resources, a trade-off which has been overlooked by earlier investigators.

TABLE OF CONTENTS

THE GEORGE WASHINGTON UNIVERSITY
School of Engineering and Applied Science
Institute for Management Science and Engineering
Program in Logistics

THE SUPPLY OF VOLUNTEERS TO THE ARMED FORCES REVISITED*

by

James T. Bennett
Sheldon E. Haber
Peter J. Kinn

I. Introduction

A number of studies such as those of Fisher [8], Altman [1], Fechter [6], Cook [5], and Gray [10] have attempted to estimate the supply of first term volunteers for military service.[1] The principal purpose of these studies is to estimate the wage and unemployment elasticities of the supply of volunteers in order to determine the increases in military pay necessary to provide manpower for the armed services in the absence of a draft. Although different in detail, all the studies, in general, reach the same conclusion: the supply of volunteers is responsive to increases in the ratio of military to civilian wages and to unemployment. Based on these studies, the estimated additional

---

*The authors are grateful to Joseph M. D'Amalio and William B. Hise for their programming assistance.

[1] Two types of volunteers are distinguished in the literature: "true" volunteers who would enter military service without a draft and "draft-induced" volunteers. The term "volunteers" as used here always refers to true volunteers.

cost of an all-volunteer armed service of about 2.65 million men ranges between $2.1 and $8.3 billion per year.[2] The relationship between enlistments and expenditures other than military pay has received virtually no theoretical or empirical consideration. The purpose of this paper is to show that failure to take into account such expenditures, specifically, in the form of resources employed in manpower recruitment, produces a misspecification that results in biased estimates of the wage and unemployment elasticities. It is also shown that if the approach used in earlier studies is applied to 1970 enlistment data, the estimated wage elasticities are lower than previously reported, which may reflect changes in attitudes toward military service.

The implications of these findings are important. The supply of volunteers may not be as responsive to military wage increases as previously indicated, and consequently, if wage increases alone are employed to obtain an all-volunteer military establishment, the cost is likely to be greater than anticipated. Further, the economic trade-off that exists between military wage increases and expenditures on resources employed in manpower procurement has been overlooked, and quite possibly other trade-offs as well.

The substantive portion of this study is presented in the next three sections. First there is a brief review of the essential characteristics of earlier work. In section III, the general approach of the earlier studies is applied to 1970 data for each service to estimate wage and unemployment elasticities under draft and no-draft environments. Some institutional aspects of the recruitment process are noted and, when a measure of recruiting effort is included in the estimation equations, it is shown that the wage and unemployment elasticities change considerably. The final section contains the conclusions and implications of the findings.

---

[2] The $2.1 billion estimate was given by Canby and Klotz [4] and the $8.3 billion figure was derived by Altman and Fechter [2]. Oi [14] states that the Department of Defense has estimated the cost to be between $4 and $17 billion.

II. An overview of studies of the supply of volunteers

All earlier studies of the supply of military volunteers have two features in common. Each attempts to estimate a wage elasticity based upon the ratio of military to civilian wages and each incorporates some measure of unemployment, though not all compute the unemployment elasticity of supply. With minor exceptions, the economic rationale of these studies is very similar and follows the theoretical model first provided by Fisher [8]. In detail, however, there were wide variations in the studies with respect to the variables included, the definitions of the variables, the age groups considered, the branch of service for which the analyses were conducted, functional form, and the quality of enlistees as measured by mental group.[3]

The emphasis here is not on the differences among the various models, but that in spite of these differences the conclusions are generally in close agreement. Therefore, only an overview is given of the studies. The basic model is of the form

$$E = f(w_m/w_c,\ U,\ \text{Other Variables})\ ,$$

where

E is the enlistment rate (by service, age group, and mental group), i.e., enlistees as a proportion of the corresponding qualified military availables (QMA);[4]

---

[3] Mental Group (MG) is an indicator of mental aptitude based on Armed Forces Qualification Test scores. There is an approximate relationship between MG and IQ (shown in parentheses): MG I ($\geq$ 130), MG II (110-129), MG III (90-109) and MG IV (< 90).

[4] QMA is the estimated number of 17-21 year-old males in a geographic area that are mentally and physically qualified for military service. Fisher [8] and Hause and Fisher [11] employed the total number of 18-19 year-old males in the calculation of the enlistment rate; all others used QMA.

w_m/w_c is the ratio of military to civilian wages, and

U is the unemployment rate.

In some instances, the wage and unemployment variables were combined in order to provide an "expected relative wage," i.e., to weight the relative wage by the rate of unemployment. Other variables such as seasonal dummies, a Vietnam War dummy, the number of Vietnam casualties, and measures of draft pressure were used in the time series studies. In the cross-sectional analyses performed by Gray, [10], a North-South dummy was included but was significantly different from zero in only one instance.

Table I contains the wage and unemployment elasticities from some of the studies. Both the time series studies which cover the period 1957-1968 and cross-section analyses for 1963 and 1964 are shown for a draft and no-draft environment. Generally, some segment of the 17-21 "prime age group" was regarded as the target population and the estimates were usually limited to Mental Groups (MG) I-III. Mental Group IV enlistees were excluded from the studies where possible because of Department of Defense (DOD) regulations concerning the number of MG-IV's accepted by each service.

Four functional forms have been used. The log-linear or constant elasticity model was most frequently selected, but linear, semi-log and complement equations which permit changing elasticities were fitted as well. Two approaches were taken to the problem of estimating the enlistment rates of volunteers in a draft-free environment. One method was to multiply enlistment rates by volunteer rates estimated from the 1964 DOD survey of draft-induced enlistees by service, age, geographical region and mental group.[5] In the time-series analyses conducted by Fechter, Cook, and Fisher, a draft pressure variable was incorporated to account for draft-induced enlistments.

---

[5] For a discussion of the survey, see Altman [1].

TABLE I

ESTIMATES OF WAGE AND UNEMPLOYMENT ELASTICITIES FROM SELECTED STUDIES

Study	Year	Environment	Service	Age Group	Mental Group	Functional Form	N[d]	$\bar{R}^2$	Elasticities[a] Wages	Elasticities[a] Unemployment
Fisher [8][c]	57-III-65-III	Draft	All	17-20	I-III	Semi-log	33	.88	.46++	.11
	57-III-65-III	No Draft	All	17-20	I-III	Semi-log	33	.88	.74++	.18
Fechter [6][c]	58-I-68-IV	No Draft	Army	17-21	I-III	Linear	44	.51	1.24+	b
Cook [5][c]	58-I-67-II	No Draft	Air Force	16-20	I-IV	Log-linear	38	.75	2.19++	.22
	58-I-67-II	No Draft	Air Force	16-20	I-III	Log-linear	38	.75	2.23++	.24
	58-I-67-II	No Draft	Air Force	16-20	I-II	Log-linear	38	.76	2.15++	.24
Altman [1]	1963	Draft	All	17-20	I-III	Log-linear	9	.78	.38++	.19++
	1963	No Draft	All	17-20	I-III	Log-linear	9	.59	.80++	.34+
	1963	No Draft	All	17-20	I-III	Complement	9	.64	.81+	.26
	1963	Draft	Army	17-20	I-III	Log-linear	9	.55	.54+	.25+
	1963	No Draft	Army	17-20	I-III	Log-linear	9	.65	1.10+	.41+
	1963	No Draft	Army	17-20	I-III	Complement	9	.73	1.18+	.33+
Gray [10]	1964	No Draft	Army	18-21	I-III	b	34	.31	1.77++	b
	1964	No Draft	Navy	18-21	I-III	b	34	.10	.82+	b
	1964	No Draft	Air Force	18-21	I-III	b	34	.03	1.27++	b
	1964	No Draft	Marines	18-21	I-III	b	34	.04	-.12	b

[a] A + (++) indicates that the coefficient from which the elasticity estimate was derived is significantly different from zero at the 0.10 (0.05) level with a one-tail test.

[b] Not given.

[c] Time series analyses; all others are cross-section studies.

[d] Number of observations.

It is evident from Table I that a positive relationship is indicated between enlistment rates and the ratio of military to civilian wage rates and between enlistment rates and unemployment rates. The unemployment elasticities, however, are much lower than the relative wage elasticities and are not as statistically significant. Apart from the early studies of Altman and some of Fisher's results, nearly all of the estimates of the relative wage elasticity are in excess of unity, and with the exception of Marine volunteers are significantly different from zero. In his summary of the various studies prepared for the President's Commission on an All-Volunteer Armed Force, Gilman [9] asserts that the relative wage elasticity of the supply of first term volunteers is at least 1.25 and uses this value to obtain pay scales required to raise an all-volunteer force. Moreover, he states that this estimate is conservative, because "most of the remaining identifiable biases are on the negative side."[6]

An assessment of the earlier studies on both econometric and methodological grounds suggests that additional study of the supply of volunteers is required. Altman's cross-section analyses are based on only nine observations, which correspond to the geographical regions identified in the 1964 DOD survey. The small number of degrees of freedom limits the statistical reliability of his estimates. Although Gray increased the sample size by grouping states, he assumed that enlistment rates do not vary by state within each of the nine regions of the 1964 survey. This assumption is questionable.[7] Further, the years for which the cross-section analyses of Gray and Altman were conducted may not reflect changes in attitudes toward military service resulting from the Southeast Asian conflict. The time series studies that include a measure of draft pressure are subject to the criticism which Canby and

---

[6] Gilman [9], p. II-1-14.

[7] In the present study, significant differences in volunteer enlistment rates based on lottery numbers were found among states. See the Appendix for a discussion of the computation of enlistment rates for volunteers based on lottery numbers.

Klotz direct toward Fisher's work, namely that his estimates of the wage elasticity are biased downward due to simultaneous equation bias. It is interesting that Fisher's relative wage elasticity is also greater than unity after correction for this bias. Gilman reviews a number of other data and measurement problems associated with earlier studies.

In summary, both econometric and methodological criticisms can be directed toward earlier estimates of the wage and unemployment elasticities of the supply of volunteers to the armed forces. Moreover, these studies are likely dated in terms of current attitudes toward military service. In light of the commitment of the government to an all-volunteer armed service by June, 1973, it is imperative that more reliable estimates of the parameters of the supply function of volunteers be obtained.

III. Estimates of the parameters of the supply function of volunteers from 1970 data

In keeping with the earlier literature, relative wage and unemployment elasticities are provided in both draft and no-draft environments for each of the services. Estimates were made for calendar year 1970 from cross-section data based on 33 state groups for the Marine Corps, 27 for the Air Force, and 29 for the Army and Navy. The dependent variable for the draft environment is the first-term enlistment rate by mental group, denoted by Y ; for the no-draft environment, the enlistment rate of volunteers is estimated by employing lottery number data provided by DOD. The independent variables are the ratio of military to civilian wages, $W = w_m/w_c$, where w_m represents regular military compensation and w_c is the estimated annual wage of production workers in manufacturing, and the aggregate unemployment rate, U . The observation units for which variables are measured are state groups corresponding to service recruiting markets.[8]

---

[8] An explanation of the variables and the state groupings is presented in the Appendix.

Four functional forms were fitted, i.e.,

Linear: $Y = \alpha + \beta_1 W + \beta_2 U$,

Log-linear: $\ln Y = \alpha + \beta_1 \ln W + \beta_2 \ln U$,

Complement: $\ln(1-Y) = \alpha + \beta_1 \ln W + \beta_2 \ln U$, and

Semi-log: $Y = \alpha + \beta_1 \ln W + \beta_2 \ln U$.

The log-linear model produces constant elasticity estimates with respect to relative wages (β_1) and unemployment (β_2). The linear, complement, and semi-log models, however, permit changing elasticities as shown below. In particular, as the enlistment rates increases, greater increases in the ratio of military to civilian pay are required to induce additional volunteers.

Model	Relative Wage Elasticity	Unemployment Elasticity
Linear	$\beta_1(W/Y)$	$\beta_2(U/Y)$
Complement	$-\beta_1[(1-Y)/Y]$	$-\beta_2[(1-Y)/Y]$
Semi-log	β_1/Y	β_2/Y

The elasticities for these three functional forms were evaluated at the means of the variables ($\bar{U}$, $\bar{W}$, $\bar{Y}$). Only the results from the log-linear and complement functional forms are presented since the estimates vary little by functional form. The elasticities derived from the complement form were the highest, while those from the log-linear equations were the lowest.

In Table II, two sets of relative wage and unemployment elasticities are shown by service, draft environment, mental group, and functional form. The first set of elasticities were obtained from a model employing the general approach taken in earlier studies; the set of

TABLE II

ESTIMATED WAGE, UNEMPLOYMENT, AND RESOURCE ELASTICITIES[a] BY SERVICE, DRAFT ENVIRONMENT, MENTAL GROUP AND FUNCTIONAL FORM[b]

Service	Draft	Mental Group	Functional Form	$\bar{R}^2$	Elasticities[c] w_m/w_c	U	$\bar{R}^2$	Elasticities[c] w_m/w_c	U	R
Army	Yes	I-III	LL	.12	.45++	-.03	.25	.35++	-.04	.42++
			C	.15	.48++	-.00	.28	.39++	-.00	.40++
		I-II	LL	.01	.20	-.02	.12	.04	-.03	.68++
			C	.01	.29	-.02	.15	.16	.01	.58++
	No	I-III	LL	.13	.75++	.02	.17	.65++	.02	.43+
			C	.13	.80++	.08	.21	.71++	.08	.41+
		I-II	LL	.01	.50++	.03	.10	.34	.02	.69++
			C	.03	.64++	.10	.14	.51+	.09	.58++
Air Force	Yes	I-III	LL	.17	.72++	.02	.39	.47++	.03	.42++
			C	.19	.72++	.06	.40	.49++	.07	.40++
		I-II	LL	.13	.64++	.06	.38	.38+	.06	.43++
			C	.17	.66++	.10	.40	.42+	.11	.41++
	No	I-III	LL	.19	1.00++	.26	.42	.64++	.27+	.61++
			C	.21	1.02++	.28	.43	.67++	.29+	.60++
		I-II	LL	.19	.92++	.29	.47	.55+	.30+	.62++
			C	.25	1.00++	.33+	.51	.64++	.34++	.60++
Marines	Yes	I-III	LL	.01	.22	.25+	.27	.26	.04	.43++
			C	.03	.32	.27+	.26	.36+	.06	.42++
		I-II	LL	.05	.26	.18+	.25	.29	-.04	.43++
			C	.03	.41+	.19+	.24	.44++	-.01	.39++
	No	I-III	LL	.06	.37	.32++	.18	.39+	.15	.34++
			C	.10	.45+	.38++	.19	.48+	.23	.31++
		I-II	LL	.03	.40+	.24+	.17	.43+	.07	.34++
			C	.09	.53++	.29+	.18	.55++	.15	.28++
Navy	Yes	I-III	LL	.07	-.53++	.11	.77	-.16	.02	.54++
			C	.04	-.49++	.07	.76	-.12	-.02	.53++
	No	I-III	LL	.05	-.60++	.12	.73	-.17	.02	.62++
			C	.05	-.59++	.06	.71	-.17	-.04	.59++

[a] See note a, Table I.

[b] LL = Log-linear; C = Complement

[c] Independent Variables: w_m/w_c = Ratio of military to civilian wages; U = Unemployment; R = Resource.

estimates in the last four columns were derived from a model which also included a measure of recruiting resources. Although the discussion will be limited to the estimates for a no-draft environment, the elasticities are also given for the draft environment for consistency with earlier studies and to show that the wage elasticity is always greater for volunteers. Like Cook, we also show estimates of MG I-II as well as MG I-III for all services (except the Navy).[9] Because the majority of first term volunteers are in the prime age group of 17 to 21 years, the age distribution in the present study corresponds closely to that of earlier investigations.

A comparison of Table I and the first set of comparable elasticities in Table II indicates that the relative wage elasticities of volunteers obtained from 1970 data are considerably lower than indicated by earlier studies regardless of branch of service or functional form. The wage elasticity of Army MG I-III volunteers was earlier reported to range between 1.10 (Altman) and 1.77 (Gray). The comparable estimates from 1970 data are between 0.75 and 0.80 depending on functional form. The decline in wage responsiveness of Air Force volunteers is equally dramatic. The relative wage elasticity of Air Force MG I-III volunteers is about unity, less than half the value obtained by Cook (2.23) and considerably lower than Gray's estimate (1.27). In agreement with Cook's findings, the wage elasticity of MG I-II volunteers is slightly less than the estimate for MG I-III volunteers. Gray reported a negative, though not statistically significant, wage elasticity for Marines and an inelastic wage response (.82) by MG I-III Navy volunteers. In contrast, it appears that Marine Corps volunteers exhibit a positive, but small, wage response and that for Navy volunteers there is a negative and highly significant wage elasticity. It is shown later that this unexpected result for the Navy can be largely explained by misspecification of the model. It is evident that the estimated relative wage elasticities for volunteers are,

---

[9]Information on MG I-II enlistments was not available for the Navy.

in every case, much lower than the estimates provided by earlier research and are considerably below the 1.25 value used by Gilman. The differences between the elasticities reported earlier and those noted above are very likely due to changes in attitudes toward military service since the Vietnam conflict and the method of identifying true volunteers.[10] Relative to the wage elasticities, the unemployment elasticities are small and, aside from Marine volunteers, not significantly different from zero. These results are in agreement with the findings of Fisher and Cook, but contrast with Altman's conclusion that Army volunteers are responsive to the unemployment rate.

As stated in the Introduction, all earlier studies of the supply of volunteers fail to consider the importance of resources employed by the military services in meeting manpower requirements. Thus, an implicit assumption is that an increase in the number of recruiters, ceteris paribus, would have no appreciable effect on enlistment rates. However, according to a youth survey conducted for DOD, the recruiter is an important factor in the enlistment decision.[11] Recruiters serve as "salesmen" for their branch of service and attempt to induce prospects to enlist by explaining the advantages of military service and conveying information about the alternative education, training programs and geographical guarantees that are offered. In 1971 the Department of Defense authorized substantial increases in the numbers of recruiters assigned to each service. The Marine Corps, for example, was allotted an additional 465 recruiters to supplement their FY 1971 contingent of 1,235 recruiters -- a 37 percent increase. In the light of this recent

---

[10]The identification of volunteers by lottery number more accurately reflects current military preferences among the prime enlistment group and is immune to the criticisms that Fisher [8] leveled against attitude surveys.

[11]"The American youth attribute considerable influence to the recruiter in the enlistment decision. Some form of recruiter contact is reported by 48% [of the sample]." See Human Resources Research Organization [12], p. 4.

action by DOD, it is imperative to ascertain the effect of recruiting resources on enlistment rates. Moreover, because recruiting resources influence enlistment rates, the omission of this relevant variable from the model produces biased and inconsistent estimates of the wage and unemployment elasticities.

An ideal indicator of resource inputs would take into account not only recruiter effort, but also advertising and other expenditures by geographic area. Typically, recruiter man-hours would be the indicator of recruiter resource input. Data for this measure are not available, however, and advertising expenditures are not reported by recruiting market. In this study, the resource variable is measured in terms of the number of recruiters per 1000 QMA in each recruiting market and is denoted by R . This variable takes into account the quantity of resources relative to the size of the market. The resource variable was added to the four functional forms and relative wage, unemployment, and resource elasticities were computed. The resource elasticity can be interpreted as the percent change in the enlistment rate which accompanies a one percent change in the number of recruiters per 1000 QMA. The estimated elasticities derived from this model are shown in the last three columns of Table II.

A comparison of the appropriate columns in Table II indicates that the introduction of the resource variable into the model markedly alters the empirical results. In every case, there is a pronounced increase in the coefficient of determination adjusted for degrees of freedom which suggests an improved specification of the model. In general, both wage and unemployment elasticities are lower when recruiting resources are taken into account. Of major importance is the reduction in wage responsiveness for Air Force and Army volunteers.[12] For MG I-II and MG I-III, the wage elasticity of Air Force volunteers falls from near unity to about 0.65 -- a reduction of almost one-third.

---

[12]Note, however, that the rank ordering of the services with respect to the wage rate elasticity does not change when resources are added to the model.

The corresponding decline for MG I-III Army volunteers is about twelve percent, but for MG I-II the reduction is considerably greater and the wage coefficients lose statistical significance. This behavior suggests a possible deterioration in the quality of Army enlistees in the absence of the draft. The addition of the resource variable also produces slight increases in the wage responsiveness of Marine volunteers, and although still negative, the wage elasticities of Navy volunteers are now not significantly different from zero. Considerations other than wages may induce individuals to enlist in the Navy, e.g., the opportunity to "see the world" and the desire to avoid land-based combat during the Southeast Asian conflict.

The addition of the resource variable to the model also produces changes in the unemployment elasticities. The most dramatic shift in magnitude and significance occurs for Marine volunteers where the unemployment elasticity falls in value and statistical significance relative to the corresponding values in the misspecified model. Although the estimated unemployment elasticities for Air Force volunteers do not vary widely in magnitude between the two models, the unemployment elasticity becomes statistically significant when a measure of recruiting effort is included. For the Army and Navy, the unemployment elasticities are not significantly different from zero with or without the resource variable. Overall, it appears that the unemployment rate plays a minor role in the determination of enlistment rates except for Air Force volunteers.

It is clear from the resource elasticity estimates shown in Table II that recruiting effort is an important determinant of enlistment rates. Without exception, the coefficients of the resource variables are highly significant and for Air Force volunteers the resource elasticity is as large as the wage elasticity. Resources are the only significant variable in the explanation of the enlistment rate of Navy volunteers, and the elasticity for this variable is relatively large in magnitude. It appears that Marine volunteers are the least sensitive to the efforts of recruiters. This reflects the fact that the Marines

offer no specific training, organizational, or geographical guarantees, and have slower promotion rates than other services.[13]

Given the magnitude and statistical significance of the resource elasticities relative to the wage elasticities for all services, it is evident that for military manpower procurement an important economic trade-off exists between military wage increases and increases in recruiting resources. For example, in FY 1970, the total Marine Corps manpower procurement budget (including pay and allowances for recruiters) was $22.0 million.[14] A one percent increase in these resources would increase the mean enlistment rate of MG I-III's by between .31 and .34 percent. In contrast, a one percent increase in the ratio of military to civilian wages would produce an increase of between .39 and .48 percent in the mean enlistment rate. Clearly, the wage increase produces a larger enlistment response than the increase in recruiter resources. However, relative to the slight difference in response of enlistment rates, the total cost associated with a one percent raise in military wages obviously is far greater than the cost associated with a one percent increase in recruiter resources. Equally obvious, however, is the fact that an all-volunteer military establishment cannot be raised merely by continuing to increase the number of recruiters. The question of the least cost combination of increases in recruiting resources and increases in military wage rates deserves greater attention but is beyond the scope of this paper.[15]

---

[13] The other services also promote all recruits to E-2 upon completion of recruit training; only 10 percent of Marine recruits are promoted to E-2 at the end of this period.

[14] See Feldman [7], p. 19.

[15] In another paper [3], the authors have shown that recruiters are allocated geographically on the basis of QMA in each recruiting market and that increases in recruiter productivity can be achieved by the reassignment of recruiters from areas where enlistment rates are low to areas where these rates are higher.

IV. Conclusions

The principal conclusion of this research is that, without exception, all earlier studies of the supply of volunteers require modification for two reasons. First, if the general approach of earlier investigators is applied to 1970 enlistment data, one finds, with the exception of the Marine Corps, markedly lower estimates of the wage elasticity of volunteers, regardless of mental group or form of estimating equation. Therefore, earlier studies are dated, probably because current attitudes toward military service differ from pre-Vietnam attitudes. Secondly, and much more important, earlier models are misspecified because they fail to consider the role of manpower procurement resources in the recruitment of volunteers. To date, interest has focused exclusively on the level of military pay required to raise an all-volunteer military establishment. The relationship between enlistment rates and other types of expenditures, e.g., expenditures for recruiter resources, has received little theoretical or empirical attention. When a measure of recruiter resources is included in the general approach used by earlier investigators, the wage elasticity estimates change for all services. For example, further declines occur in the wage elasticity of volunteers to the Army, the service that will be most affected by a no-draft environment.

As noted, Gilman has asserted that the wage elasticity for all volunteers is at least 1.25. This value may be compared with weighted average wage elasticity from this study. To obtain a wage elasticity for all volunteers, we weight the MG I-III wage elasticities for each service[16] by the estimates derived by Canby and Klotz of the number of required MG I-III accessions in a no-draft environment for each service.[17] If the wage elasticities are taken from the log-linear model excluding the resource variable, the weighted average wage

[16] Because the Navy wage elasticities were negative and not statistically significant, these were assumed to be zero.

[17] See [4], Table 25, p. 87.

elasticity for all volunteers based on 1970 data is 0.82 -- nearly 35 percent below the figure used by Gilman. When the resource variable is taken into account in the model, the weighted average wage elasticity declines further to 0.62 -- slightly less than half of the 1.25 value. Comparable estimates based on the complement functional form are marginally higher, 0.86 and 0.67, respectively. These findings suggest that the wage increases required to raise an all volunteer force are substantially greater than previously suggested, perhaps by as much as 100 percent.

With respect to the responsiveness of volunteers to changes in the unemployment rate, Klotz [13] has recently asserted that the unemployment elasticity may be as high as 0.62. In this study, the unemployment elasticities are found to depend upon the specification of the model and to vary by service. When the recruiter resource is considered, the unemployment elasticity is significantly different from zero only for the Air Force; and for this service it is only 0.34. We conclude, therefore, that over all military services the unemployment elasticity is quite small. Another major finding is the significance of manpower procurement resources in the determination of enlistment rates. Not only does the inclusion of resources in the model alter the wage and unemployment elasticities, it also produces a marked increase in the explanatory power of the model as measured by the adjusted coefficient of determination. The resource elasticities are highly significant statistically for all services and large in magnitude relative to the wage elasticities. It is clear that for each service an economic trade-off exists between military wage increases and increases in expenditures for manpower procurement resources. Trade-offs between pay and other policy variables, e.g., length of enlistment, enlistment bonuses, promotion rates, etc., may also be important.

One further finding is suggested by the empirical results. The elasticity estimates indicate differing responses of volunteers to wage incentives and recruiters by service. As an example, Marine Corps enlistments exhibit both a low wage and resource elasticity relative to

the other services. One possible explanation of this behavior is that the Marine Corps offers no geographic or organization guarantees and limited training guarantees to potential volunteers. This low responsiveness of volunteers to wage incentives and recruiters might be overcome by increasing the range of guarantees available, or if this is inconsistent with the mission of the Marine Corps, differential pay or other monetary inducements, such as the proposed $3,000 combat arms enlistment bonus now being considered by the Army, may need to be introduced. The determination of the optimum combination of wages, recruiting resources, and other monetary and non-monetary benefits required to recruit an all volunteer military service is obviously beyond the scope of this study and requires intensive investigation. From this study it is evident that the determination of the wage elasticity is only one part of the problem of identifying the factors that influence the enlistment decision.

REFERENCES

[1] Altman, Stuart H. "Earnings, Unemployment and the Supply of Enlisted Volunteers." Journal of Human Resources, IV-1 (1969), 38-59.

[2] ________________, and Fechter, Alan E. "The Supply of Military Personnel in the Absence of a Draft." American Economic Review, LVII (May, 1967), 19-31.

[3] Bennett, James T., and Haber, Sheldon E. On the Application of Marginal Productivity Analysis to the Allocation of Recruiters Within the Military Services. Institute for Management Science and Engineering, The George Washington University, Washington, D. C. (Forthcoming).

[4] Canby, S. L., and Klotz, B. P. The Budget Cost of a Volunteer Military. The Rand Corporation, Santa Monica, California, August, 1970.

[5] Cook, Alvin A., Jr. The Supply of Air Force Volunteers. The Rand Corporation, Santa Monica, California, September, 1970.

[6] Fechter, Alan E. "Impact of Pay and Draft Policies on Army Enlistment Behavior," in The President's Commission on an All-Volunteer Force, The Report of the Presidential Commission on an All-Volunteer Force, II-3-1-59. Washington, D.C.: Government Printing Office, November, 1970.

[7] Feldman, R. S. "A Consideration of Selected Determinants of Costs in Marine Corps Recruiting." Center for Naval Analyses, September, 1971 (Mimeographed).

[8] Fisher, Anthony C. "The Cost of the Draft and the Cost of Ending the Draft." American Economic Review, LIX (1969), 239-254.

[9] Gilman, Harry J. "Supply of Volunteers to the Military Services," in The President's Commission on an All-Volunteer Force, The Report of the Presidential Commission on an All-Volunteer Force, II-1-1-26. Washington, D.C.: Government Printing Office, November, 1970.

[10] Gray, Burton C. "Supply of First-Term Military Enlistees," in The President's Commission on an All-Volunteer Force, The Report of the Presidential Commission on an All-Volunteer Force, II-2-1-40. Washington, D.C.: Government Printing Office, November, 1970.

[11] Hause, John C., and Fisher, Anthony C. The Supply of First-Term Enlisted Manpower in the Absence of a Draft. Institute for Defense Analyses, April, 1968.

[12] Human Resources Research Organization. Attitudes of Youth Toward Military Service: Results of a National Survey Conducted in May 1971. Human Resources Research Organization, Alexandria, Virginia, October, 1971.

[13] Klotz, Benjamin P. "The Cost of Ending the Draft: Comment." American Economic Review, LX (December, 1970), 970-978.

[14] Oi, Walter Y. "The Economic Cost of the Draft." American Economic Review, LVII (May, 1967), 39-62.

[15] U.S. Department of Labor. "Area Trends in Employment and Unemployment." July, 1971.

[16] U.S. Department of Labor. "Employment and Earnings and Monthly Report on the Labor Force." Various Issues.

APPENDIX

Grouping of states into observational units

The inclusion of the resource variable into the supply model required an analysis of recruiting markets for each service. As of 1 July 1971, the number of recruiting markets for the Air Force, Army, Marine Corps and Navy were 46, 40, 41 and 37, respectively. Since the data on enlistments, QMA, wages and unemployment were reported by state, it was necessary to aggregate states into observational units corresponding to one or more recruiting markets. Due to differences in boundaries of recruiting markets among services, the number of observations differed by service. The number of observations was 27 for the Air Force, 33 for the Marines, and 29 for the Army and Navy. The states in each observational unit for each service are shown in the Appendix of [3].

Relative wage variable

The relative wage variable was lagged by six months in the supply model, i.e., fiscal year (FY) 1970 military and civilian wages were employed in the model with calendar year (CY) 1970 enlistments. Military wage data were provided by the Compensation Studies Directorate, Office of the Secretary of Defense. For FY 1970, data pertaining to regular military compensation (consisting of annual basic pay, allowances for quarters and subsistence, and the Federal tax advantage) were obtained for the enlisted grades E-1 through E-4. The estimates of annual military compensation by grade were then weighted by the number of men in each grade to determine the weighted average military pay, w_m. The civilian wage variable, w_c, was calculated for FY 1970 from monthly wage and employment data in [16] for production workers in manufacturing. For each state group, a weighted average of hourly wage rates was computed using the number of production workers in manufacturing as weights. The weighted hourly wage rates were then multiplied by 2,080 (assuming a standard work week of 40 hours for a 52 week period) to obtain an annual wage for each state group.

Unemployment variable

Unemployment rates by state group were derived using average monthly work force and unemployment data published annually in [15]. CY 1969 unemployment rates were used in the model with CY 1970 enlistments resulting in a one-year lag on the unemployment variable.

Resource variable

The recruiter resource variable is defined as the number of recruiters per 1,000 QMA. Data were obtained from each service showing the number of recruiters in each recruiting market. These data were aggregated for each observational unit to determine the numerator of the recruiter resource variable. The computation of QMA by state group is described below in the discussion of enlistment rates.

Volunteer rates

The volunteer rate is the ratio of volunteers to all enlistments. The method used to compute volunteer rates is that employed by the Selective Service System. The data provided by DOD consisted of male non-prior service enlistments by service, state and lottery number for CY 1970. Volunteer rates by service and state group were calculated by dividing the number of enlistees age 19-26 with draft lottery numbers 241-366 by (241-366)/366 times total enlistments age 19-26. In this computation enlistees with lottery numbers 241 or higher are assumed to be volunteers. The denominator is an estimate of the enlistees having a similar number of birth dates as the volunteer group, under the assumption that the probability of an enlistee being a volunteer is independent of his birth date.

Enlistment rates

The enlistment rate is defined as the number of enlistments in a mental group per 1,000 QMA of that mental group. Data were obtained from each service on male enlistments by mental group and recruiting market.

These data were aggregated for each observational unit and used as a basis for calculating the number of enlistments by mental group, service and state group. QMA by state group was then computed as follows: First, the male population age 17-21 was obtained from preliminary 1970 Census of Population data. Second, from data supplied by the Office of the Surgeon General, the ratio of examinees found acceptable for induction to the total number examined was calculated. This ratio is the acceptance rate. Third, the acceptance rate was multiplied by the male population age 17-21 to obtain estimated QMA by state group. In a final computation, for each state group, QMA by mental group was computed by multiplying QMA by the ratio of the number of acceptables in each mental group to the total number of acceptables.

To obtain volunteer enlistments, enlistments by mental group, service and state group were multiplied by the volunteer rate for each service and state group. Due to limitations in data, this procedure assumes that for a given service the structure of volunteer rates among mental groups is the same for each state group. The level of volunteer rates, however, can differ from state group to state group. These differences in levels are measured by the DOD lottery data.

THE GEORGE WASHINGTON UNIVERSITY
Program in Logistics
Distribution List for Technical Papers

Copies	
7	The George Washington University
	1 Office of Sponsored Research
	2 Library
	1 Vice President H. F. Bright
	1 Dean Harold Liebowitz
	1 Prof. S. Kullback, Dept. of Stat.
	1 Mr. J. Frank Doubleday
4	ONR
	3 Chief of Naval Research (Code 430D)
	1 Contract Administrator, SEA
5	OPNAV
	1 OP-40
	1 DCNO, Logistics
	1 Navy Dept. Library
	1 Oper Eval Group
	1 Op-354
1	Naval Applied Science Lab
1	Naval Aviation Integrated
1	NAVCOSSACT
1	Naval Cmd Sys Sup Activity Tech Library
1	Naval Electronics Lab Ctr
1	Naval Facilities Engng Cmd Tech Library
2	Naval Ordnance Station
	1 Louisville, Ky.
	1 Indian Head, Md.
1	Naval Ordnance Sys Cmd Library
5	Naval Research Branch Office
	1 Boston
	1 Chicago
	1 New York
	1 Pasadena
	1 San Francisco
7	Naval Research Lab
	1 Tech Info Div.
	6 Library, Code 2029 (ONRL)
1	Naval Ship Engng Center, Phila.
1	Naval Ships Res & Dev Center
2	Naval Ship Sys Cmd
	1 Tech Library
	1 Mr. A. E. Smith
1	Naval Supply Sys Cmd Library
1	Naval Undersea Warfare Center
2	Naval War College Library Newport
2	BUPERS Tech Library
1	FMSO
1	Integrated Sea Lift Study
1	Office of Manag Info
1	Office of Info. Sys. Plan. & Dev.
1	Systems Analysis Division
1	USN Ammo Depot Earle
3	USN Postgrad Sch Monterey
	1 Library
	1 Dr. Jack R. Borsting
	1 Prof. C. R. Jones
1	USN Purchasing Office, Brooklyn
1	HQ, USMC
1	Commandant, USMC
2	Marine Corps Sch Quantico
	1 Landing Force Dev. Ctr
	1 Logistics Officer
1	Indust College Armed Forces
1	Armed Forces Staff College

Copies	
1	Army War College Library Carlisle Barracks
1	Army Cmd & Gen Staff College
1	HQ, US Army Trans Mat Cmd TCMAC, ADST
1	Army Logistics Manag Ctr Fort Lee
1	US Army Electronic Cmd Philadelphia
1	Frankford Arsenal
1	HQ, USAF
	1 AFADS–3
1	Maxwell AFB Library
2	Wright-Patterson AFB
	1 HQ, AF Log Command
	1 Research Sch Log
12	Defense Documentation Ctr
2	NBS
	1 Dr. E. W. Cannon
	1 Dr. Joan Rosenblatt
1	National Science Foundation
1	National Security Agency
1	WSEG
3	British Navy Staff
1	ARCON Corp.
1	General Dynamics, Pomona
3	Cowles Foundation for Res
	1 Library
	1 Prof. Herbert Scarf
	1 Prof. Martin Shubik
1	IBM Rockville Dr. Harlan D. Mills
1	IBM Yorktown Heights Dr. Alan J. Hoffman
1	Planning Research Corp Los Angeles
2	Rand Corp. Santa Monica
	1 Logistics Dept.
	1 Library
2	Research Analysis Corp.
	1 Dr. Hugh Cole
	1 Library
1	Vitro Labs
3	Carnegie-Mellon University
	1 Prof. G. Thompson
	1 Dean H. A. Simon
	1 Prof. D. P. Gaver, Jr.
3	Case Western Reserve University
	1 Prof. B. V. Dean
	1 Prof. M. Mesarovic
	1 Prof. John R. Isbell
2	Columbia University
	1 Prof. C. Derman
	1 Prof. Rosedith Sitgreaves
4	Cornell University
	1 Prof. R. E. Bechhofer
	1 Prof. R. W. Conway
	1 Prof. J. Kiefer
	1 Prof. Andrew Schultz, Jr.
2	Florida State University
	1 Prof. I. R. Savage
	1 Prof. R. A. Bradley

Copies

3 Harvard University
- 1 Prof. K. J. Arrow
- 1 Prof. W. G. Cochran
- 1 Prof. Arthur Schleifer, Jr.

3 New York University
- 1 Prof. Allan Birnbaum
- 1 Prof. W. M. Hirsch
- 1 Prof. J. H. K. Kao

4 Princeton University
- 1 Prof. O. Morgenstern
- 1 Prof. A. W. Tucker
- 1 Prof. J. W. Tukey
- 1 Prof. Geoffrey S. Watson

3 Purdue University
- 1 Prof. S. S. Gupta
- 1 Prof. H. Rubin
- 1 Prof. Andrew Whinston

9 Stanford University
- 1 Prof. T. W. Anderson
- 1 Prof. H. Chernoff
- 1 Prof. G. B. Dantzig
- 1 Prof. F. S. Hillier
- 1 Prof. D. L. Iglehart
- 1 Prof. Samuel Karlin
- 1 Prof. G. J. Lieberman
- 1 Prof. Herbert Solomon
- 1 Prof. A. F. Veinott, Jr.

6 University of Calif., Berkeley
- 1 Prof. R. E. Barlow
- 1 Prof. P. J. Bickel
- 1 Prof. D. Gale
- 1 Prof. R. Radner
- 1 Prof. L. M. Tichvinsky
- 1 Prof. Willard I. Zangwill

4 University of Calif., Los Angeles
- 1 Prof. J. R. Jackson
- 1 Prof. Jacob Marschak
- 1 Prof. R. R. O'Neill
- 1 Numerical Analysis Res Librarian

1 University of Calif., San Diego
- 1 Prof. M. Rosenblatt

2 University of Michigan
- 1 Prof. Paul S. Dwyer
- 1 Prof. Seth Bonder

1 University of North Carolina
- 1 Prof. W. L. Smith and Prof. M. R. Leadbetter

2 University of Pennsylvania
- 1 Prof. Russell Ackoff
- 1 Prof. Thomas L. Saaty

2 University of Texas
- 1 Prof. A. Charnes
- 1 Prof. A. C. Stedry

3 Yale University
- 1 Prof. F. J. Anscombe
- 1 Prof. L. J. Savage
- 1 Library

1 Dr. Stewart Bessler
Decision Studies Group

1 Prof. Z. W. Birnbaum
University of Washington

1 Prof. B. H. Bissinger
The Pennsylvania State University

1 Prof. G. E. P. Box
University of Wisconsin

1 Prof. L. W. Cohen
University of Maryland

1 Prof. H. F. Dodge
Rutgers – The State University

Copies

1 RADM H. E. Eccles, USN (Ret.)
Newport

1 Dr. Howard Frank
SFD-NRAC

1 Prof. J. Gani
University of Sheffield, England

1 Dr. Saul I. Gass
Mathematica

1 Prof. J. F. Hannan
Michigan State University

1 Mr. R. A. Harker
URS Corp.

1 Prof. H. O. Hartley
Texas A & M Foundation

1 Dr. Rudolf Husser
University of Bern, Switzerland

1 Prof. W. Kruskal
University of Chicago

1 Prof. C. E. Lemke
Rensselaer Polytech Inst.

1 Dr. William G. Madow
Stanford Research Inst.

1 Dr. Jack Moshman
LEASCO Systems & Res Corp.

1 Prof. P. Naor
Israel Inst. of Tech, Israel

1 RADM J. B. Oren, USCG (Ret.)
Nat'l Academy of Sciences

1 Prof. D. B. Owen
Southern Methodist University

1 Prof. E. Parzen
State University New York, Buffalo

1 Prof. H. O. Posten
University of Connecticut

1 Prof. R. Remage, Jr.
University of Delaware

1 Dr. Fred D. Rigby
Texas Tech College

1 Mr. David Rosenblatt
Washington, D. C.

1 Prof. Alan J. Rowe
University of Southern California

1 Prof. A. H. Rubenstein
Northwestern University

1 Dr. M. E. Salveson
West Los Angeles

1 Prof. R. M. Thrall
Rice University

1 Dr. S. Vajda
University of Birmingham, England

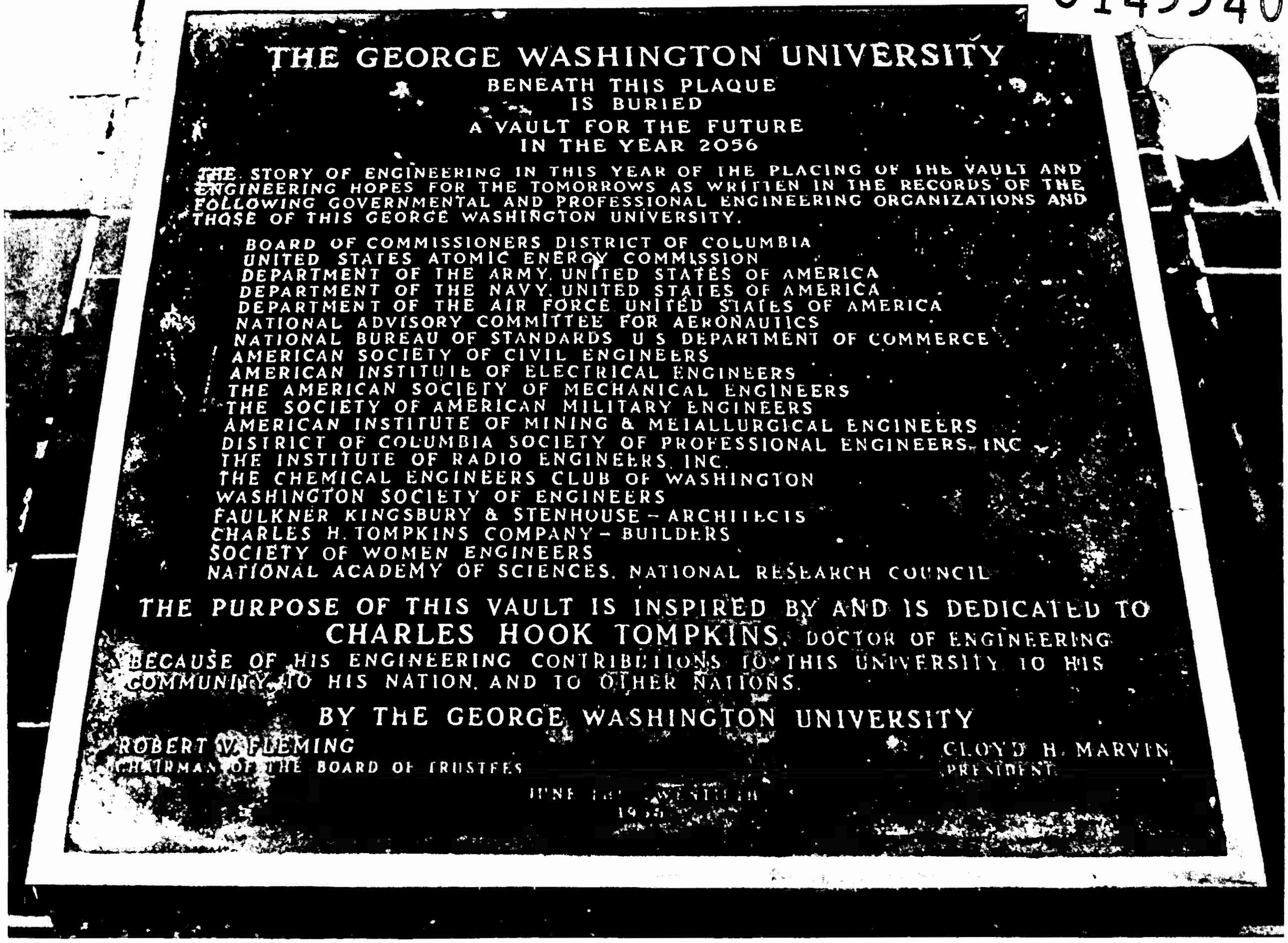
1 Prof. T. M. Whitin
Wesleyan University

1 Mr. Marshall K. Wood
Nat'l Planning Assoc.

1 Prof. Max A. Woodbury
Duke University

1 Prof. Jacob Wolfowitz
University of Illinois

U145540



To cope with the expanding technology, our society must be assured of a continuing supply of rigorously trained and educated engineers. The School of Engineering and Applied Science is completely committed to this objective.